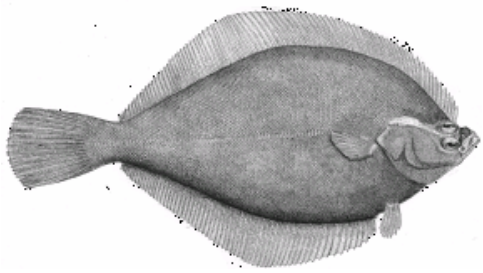

Last Revised: December 2006

Yellowtail flounder

by

Chris Legault and Steve Cadrin

Distribution, Biology and Management

The yellowtail flounder, *Limanda ferruginea*, is a demersal flatfish distributed from Labrador to Chesapeake Bay generally at depths between 40 and 70 m (20 to 40 fathoms). Off the U.S. coast, three stocks are considered for management purposes (Cadrin 2003): Cape Cod/Gulf of Maine, Georges Bank, and Southern New England/ Mid-Atlantic (Figure 7.1). Yellowtail flounder have been described as relatively sedentary, although evidence exists for off bottom movements (Walsh and Morgan 2004; Cadrin and Westwood 2004), limited seasonal movements (Royce et al. 1959; Lux 1963; Stone and Nelson 2003), and transboundary movements (Stone and Nelson 2003; Cadrin 2005).

Spawning occurs during spring and summer, peaking in May (Cadrin 2003). Eggs are deposited on or near the bottom and after fertilization float to the surface. Larvae drift for approximately two months, then change form and settle to the bottom. Off the northeast United States, yellowtail flounder grow to 55 cm (22 in.) total length and attain weights of 1.0 kg (2.2 lb). Growth is sexually dimorphic, with females growing at a faster rate than males (Lux and Nichy 1969; Cadrin 2003). Yellowtail flounder appear to have variable maturity schedules, with age two females 40% mature during periods of high stock biomass to 90% mature during periods of low stock biomass (NEFSC 2005).

The principal fishing gear used to catch yellowtail flounder is the otter trawl. Total landings of yellowtail flounder by the U.S. in 2005 were 4,118 mt, a 43% decline from the 7,202 mt landed in 2004. An additional 30 mt was landed by Canada from Georges Bank in 2005. Recreational landings of yellowtail are negligible.

United States fisheries for yellowtail flounder are managed under the New England Fishery Management Council's Northeast Multispecies Fishery Management Plan (FMP). Under this FMP, yellowtail flounder are included in a complex of 15 groundfish species managed by

time/area closures, gear restrictions, minimum size limits, and, since 1994, by direct effort controls including a moratorium on permits and days-at-sea restrictions. Amendment 9 established initial biomass rebuilding targets and defined control rules which specify target fishing mortality rates and corresponding rebuilding time horizons. Amendment 13 implemented formal rebuilding plans within specified time frames based on revised biomass and fishing mortality targets derived by the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish (NEFSC 2002). The goal of the management program is to reduce fishing mortality to allow stocks to rebuild above minimum biomass thresholds and, attain and remain at or near target biomass levels. In addition, a formal quota sharing agreement was implemented in 2004 between Canada and the U.S. to share the harvest of yellowtail in the transboundary Georges Bank management unit. The agreement includes total allowable catch quotas for each country as well as in-season monitoring of the U.S. catch of yellowtail on Georges Bank. The information provided herein reflects the results of the most recent peer-reviewed assessments for the Cape Cod-Gulf of Maine, Georges Bank, and Southern New England-Mid Atlantic yellowtail flounder stocks (NEFSC 2005, Legault et al. 2006).

CAPE COD-GULF OF MAINE YELLOWTAIL FLOUNDER

The Fishery

Cape Cod-Gulf of Maine yellowtail are generally caught in multi-species groundfish fisheries (principally by otter trawls) from late fall to spring, with some landings by gillnets in the winter and spring. Historically, landings from the stock were a small portion of the total U.S. yellowtail landings. However, during the collapse of Georges Bank and southern New England stocks in the early 1990s, landings from the Cape Cod-Gulf of Maine stock accounted for the majority of U.S. yellowtail harvest. Annual landings from the stock increased from less than 1,000 mt in the mid 1930s to a peak of 5,600 mt in 1980 (Figure 7.2). Landings decreased to approximately 1,200 mt per year in the late 1980s, but increased to 3,200 mt in 1990 due to recruitment of the strong 1987 yearclass. Landings declined to 800 mt in 1993, remained low through the 1990s, increased to greater than 2,400 mt in 2000 and 2001, but declined to 700 mt in 2005 **(**Table 7.1). Discards constitute about 20% of the total catch.

Research Vessel Survey Indices

Survey biomass indices are somewhat variable, but generally indicate high biomass in the late 1970s and early 1980s, a decline in the 1980s, a rapid increase in the late 1990s, and a recent decrease (Figure 7.3). Age structure for this stock became severely truncated during the 1980s. Despite increases in the proportion of age 4 fish during 1990s, very few fish now survive beyond this age (Figure 7.4).

Assessment Results

The 2005 stock assessment indicated that that F on ages 3+ decreased from high levels in the late 1980s to 0.28 in 1993, but gradually increased to an average of 0.9 since 2000 **(**Figure 7.5). With the exception of the strong 1987 year class (29 million at age-1), recruitment was stable

from 1985 to 2001, averaging 10 million at age 1, but has been below average since 2001 (Figure 7.6). Spawning biomass averaged 1,000 mt during the late 1980s, peaked at 3,800 mt in 1991 as the 1987 cohort matured, decreased to 1,600 mt in 1997, gradually increased to 2,700 mt in 2000, but has subsequently declined (Figure 7.6).

Biological Reference Points

The overfishing threshold, F_{MSY} is approximated as $F40\%_{MSP}$ (0.17). The SSB_{MSY} proxy is 12,600 mt, calculated as the product of 40% MSP (1.192 kg spawning biomass per recruit) and average long-term recruitment (10.5 million using VPA estimates for 1985 onward). The MSY proxy is 2,300 mt, derived as the product of yield per recruit at F40% (0.213 kg) and average recruitment (Table 7.2).

Summary

The Cape Cod-Gulf of Maine yellowtail stock is overfished, because the 2004 SSB is far below the SSB_{MSY}. Overfishing is occurring because the 2004 fishing mortality exceeds F_{MSY}.

Table 7.1 Recreational and commercial catch of Cape Cod-Gulf of Maine yellowtail flounder (thousand metric tons).

Category	1986-95 Average	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
U. S. Recreational	-	-	-	-	-	-	-	-	-	-	-
Commercial											
US Landings	1.4	1.2	1.1	1.2	1.2	2.4	2.5	2.0	1.8	0.8	0.7
US Discards	0.5	0.2	0.3	0.3	0.1	0.2	0.5	0.1	0.2	0.1	n/a
Other	-	-	-	-	-	-	-	-	-	-	-
Total Nominal Catch	1.9	1.4	1.4	1.5	1.3	2.6	3.0	2.1	2.0	0.9	0.7

Table 7.2 Yield and SSB per Recruit and MSY based reference points for Cape Cod-Gulf of Maine yellowtail flounder.

Yield and SSB per Recruit-based Reference Points

$F_{0.1}$	=	0.20
F_{max}	=	0.44
$F_{40\%}$	=	0.17

MSY-based Reference Points

MSY	=	2,300 mt
B_{msy}	=	12,600 mt

GEORGES BANK YELLOWTAIL FLOUNDER

The Fishery

Exploitation of the Georges Bank stock began in the mid-1930s by the US trawler fleet. Landings increased from 400 mt in 1935 to 9,800 mt in 1949, decreased in the early 1950s to 2,200 mt in 1956, and increased again in the late 1950s and early 1960s (Figure 7.7). The highest landings occurred during 1963-1976 (average: 14,100 mt) and included modest landings by foreign fleets. No foreign catches of yellowtail have occurred since 1975. In 1985, the stock became a transboundary resource under both Canadian and US jurisdictions. Landings averaged about 2,600 mt between 1985 and 1994, then dropped to a record low of 877 mt in 1995 when fishing effort was drastically reduced to allow the stock to rebuild. The US fishery has been constrained by spatial expansion of Closed Area II in 1994 and by extension to year-round closure in 1995, as well as by gear regulations and limits on days fished. In 2004, a Yellowtail Special Access Program (SAP) in Closed Area II allowed a US bottom trawl fishery in the area for the first time since 1995 generating US landings of 6,200 mt, the highest US harvest since 1983. This SAP did not continue in 2005. A directed Canadian fishery began on eastern Georges Bank in 1993, pursued mainly by small otter trawlers (< 20 m). Total combined landings by both countries increased (with increasing quotas) from a record low of 877 mt in 1995, when the stock was considered to be in a collapsed state, to 6,705 mt in 2001 (Table 7.3). In 2005, combined landings were 3,358 mt resulting from the US nearly filling their portion of the quota but Canada unable to catch their portion (Table 7.3). Since 1973, discards have accounted for about 20% of the total catch.

Georges Bank yellowtail flounder landings are generally dominated by ages 2-4 fish, by number (Figure 7.8). The proportion of age 1 flounder in the landings has been reduced via increases in the minimum trawl mesh size since the mid-1990s. The proportion of age 3 and older fish in the landings has increased since the mid-1990s.

Research Vessel Survey Indices

NEFSC spring and autumn biomass indices for yellowtail flounder have exhibited similar trends throughout the survey time series (Figure 7.9). A survey conducted by the Canadians in spring on Georges Bank also shows a similar pattern. Total biomass indices declined through the late 1970s into the early 1990s, increased in the mid 1990s and late 1990s, peaked in the early 2000s, but have since declined. The age structure of the yellowtail flounder population has become truncated as the stock has declined, with a low proportion of fish at ages 5 and older (Figure 7.10).

Assessment Results

Average (age 4+, unweighted) fishing mortality was close to or above 1.0 between 1973 and 1994, fluctuated between 0.6 and 0.9 during 1995 to 2003, increased in 2004 to 1.92, and then declined in 2005 to 1.37 (Figure 7.11). Spawning stock biomass of yellowtail flounder increased from a low of 2,648 mt in 1995 to an average of 10,100 mt from 1999-2003 before declining in 2004 and 2005 to 6,377 mt and 5,441 mt, respectively (Figure 7.12). Recruitment averaged 23.5 million fish at age 1 during 1998 to 2001 but has since declined to 9.2 million in 2005, well below the median of 18.3 million during the assessment time period (Figure 7.12).

Biological Reference Points

Yield and spawning stock biomass biological reference points (Figure 7.13) were last calculated in the Working Group on Re-Evaluation of Biological Reference Points for New England Groundfish (NEFSC 2002) and reported in the 2002 and 2005 GARM assessments (NEFSC 2002, 2005). The overfishing threshold, F_{MSY} is approximated as $F_{40\%MSP}$ (0.25). The SSB_{MSY} proxy is 58,800 mt, calculated as the product of 40%MSP (1.0925 kg spawning biomass per recruit) and average long-term recruitment (53.8 million using VPA estimates for 1973 onward and hindcast recruitment estimates from the 1963-1972 period). The MSY proxy is 12,900 mt, derived as the product of yield per recruit at F40% (0.240 kg) and average recruitment (Table 7.4). The fishing mortality rate used by the Transboundary Management Guidance Committee as the target value, F_{ref}, is 0.25.

The relationship between spawning stock biomass and recruitment for Georges Bank yellowtail flounder over the period covering the 1973-2004 year classes is illustrated in (Figure 7.14). The stock-recruitment trajectory indicates the position of the most recent levels of SSB and recruitment near the lower middle of the plot. The solid horizontal line indicates the median recruitment over the same period. Survival ratios, recruits per unit of spawning biomass Figure 7.15, illustrate the relatively low survival of recent year classes, in spite of the relatively high level of the recent spawning stock.

Summary

Georges Bank yellowtail flounder spawning stock biomass increased from 2,600 mt in 1995 to 5,400 mt in 2005, but is still well below the biomass threshold of ½ B_{MSY} (=29,400 mt). Fully recruited fishing mortality was about 1.4 in 2005, more than five times the fishing mortality target of F_{ref}= 0.25. Thus, the stock is in an overfished condition and overfishing continues to occur.

Table 7.3 Recreational and commercial catch of Georges Bank yellowtail flounder (thousand metric tons).

Category	1986-95 Average	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
U. S. Recreational	-	-	-	-	-	-	-	-	-	-	-
Commercial											
US Landings	2.0	0.8	1.0	1.8	2.0	3.7	3.8	2.5	3.3	6.2	3.3
US Discards	0.5	0.1	0.1	0.1	0.5	0.4	0.3	0.2	0.4	0.5	0.5
Canada Landings	0.4	0.5	0.8	1.2	2.0	2.9	2.9	2.6	2.1	0.1	0.0
Canada Discards	0.5	0.4	0.4	0.7	0.6	0.4	0.8	0.5	0.8	0.4	0.3
Other	-	-	-	-	-	-	-	-	-	-	-
Total Nominal Catch	3.3	1.7	2.3	3.8	5.0	7.4	7.9	5.9	6.6	7.3	4.2

Table 7.4 Yield and SSB per Recruit and MSY Based Reference Points for Georges Bank yellowtail flounder.

Yield and SSB per Recruit-based Reference Points

$F_{0.1}$ = 0.26
F_{max} = 0.80
$F_{40\%}$ = 0.25

MSY-based Reference Points

MSY = 12,900 mt
B_{msy} = 58, 800 mt

SOUTHERN NEW ENGLAND-MID ATLANTIC YELLOWTAIL FLOUNDER

The Fishery

A fishery for yellowtail flounder developed off southern New England in the 1930s, coincident with the increased use of otter trawls, a decline in winter flounder abundance, and demand for food products during World War II. Landings increased during the 1930s and early 1940s and the fishery expanded to the Mid Atlantic in the early 1940s. During this period, landings peaked at 28,000 mt in 1942 (Figure 7.16). Annual landings were around 10,000 mt during 1943 to 1948 with approximately 10% from the Mid Atlantic. A domestic industrial fishery developed in the late 1940s, but landings decreased to less than 2,000 mt in the mid 1950s. Landings increased again in the late 1950s and 1960s. A distant water fishery developed in the late 1960s and total annual landings exceeded 20,000 mt between 1963 and 1970. The distant water fisheries were eliminated in the early 1970s, and landings generally decreased with temporary increases in the early 1980s and early 1990s. Landings in 1995 were a record low 200 mt, and the proportion of landings from the Mid Atlantic increased from approximately 10% in the early 1990s to greater than 20%. Landings increased to greater than 1,000 mt per year at the turn of the century but declined to 220 mt in 2004 (Table 7.5). Discards accounted for about 30% of total annual catches until 1995. Since then, discards have been very low (e.g. 150 mt or less).

Research Vessel Survey Indices

Indices of abundance and biomass were high in the 1960s and early 1970s, but declined sharply in the mid 1970s (Figure 7.17). Biomass indices increased in the early and late 1980s, with the recruitment of the strong 1980 and 1987 cohorts, but have since been extremely low. Age distribution of yellowtail in surveys indicates abundant cohorts in the 1960s and early 1970s, strong year classes in 1980 and 1987, and little recruitment and a relatively truncated population age structure since the mid 1990s (Figure 7.18).

Assessment Results

The 2005 stock assessment indicated that the stock was abundant in the early 1970s but subsequently markedly declined. Fishing mortality has been high through the three decades of the assessment, 1973-2004 (Figure 7.19). Recruitment was generally strong in the 1970s and moderate during the 1980s, with two exceptional year classes in 1980 and 1987, but has been low since (Figure 7.20). Spawning biomass was high in the early 1970s, decreased in the late

1970s, increased briefly in the early and late 1980s, but declined in the early 1990s and has thereafter remained low (Figure 7.20).

Biological Reference Points

The overfishing threshold, F_{MSY} is approximated as $F_{40\%MSP}$ (0.26). The SSB_{MSY} proxy is 69,500 mt, calculated as the product of 40%MSP (1.129 kg spawning biomass per recruit) and average long-term recruitment (61.57 million using hindcast estimates for 1963 onward). The MSY proxy is 14,200 mt, derived as the product of yield per recruit at $F_{40\%}$ (0.230 kg) and average recruitment (Table 7.6).

Summary

The Southern New England-Mid Atlantic stock is overfished, because the 2004 spawning biomass is far below SSB_{MSY}. Overfishing is occurring, because the 2004 fishing mortality exceeds F_{MSY}.

Table 7.5 Recreational and commercial catch of Southern New England-Mid Atlantic yellowtail flounder (thousand metric tons).

Category	1986-95 Average	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
U. S. Recreational	-	-	-	-	-	-	-	-	-	-	-
Commercial											
US Landings	2.4	0.5	0.8	0.6	1.2	1.0	1.0	0.8	0.4	0.2	0.1
US Discards	2.3	0.1	0.0	0.1	0.1	0.0	0.1	0.1	0.1	0.1	n/a
Other	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Nominal Catch	4.7	0.5	0.8	0.7	1.3	1.0	1.1	0.9	0.5	0.3	0.1

Table 7.6 Yield and SSB per Recruit and MSY Based Reference Points for Southern New England - Mid Atlantic yellowtail flounder.

Yield and SSB per Recruit-based Reference Points

$F_{0.1}$ = 0.25
F_{max} = 0.74
$F_{40\%}$ = 0.26

MSY-based Reference Points

MSY = 14,200 mt
B_{MSY} = 69,500 mt

For further information

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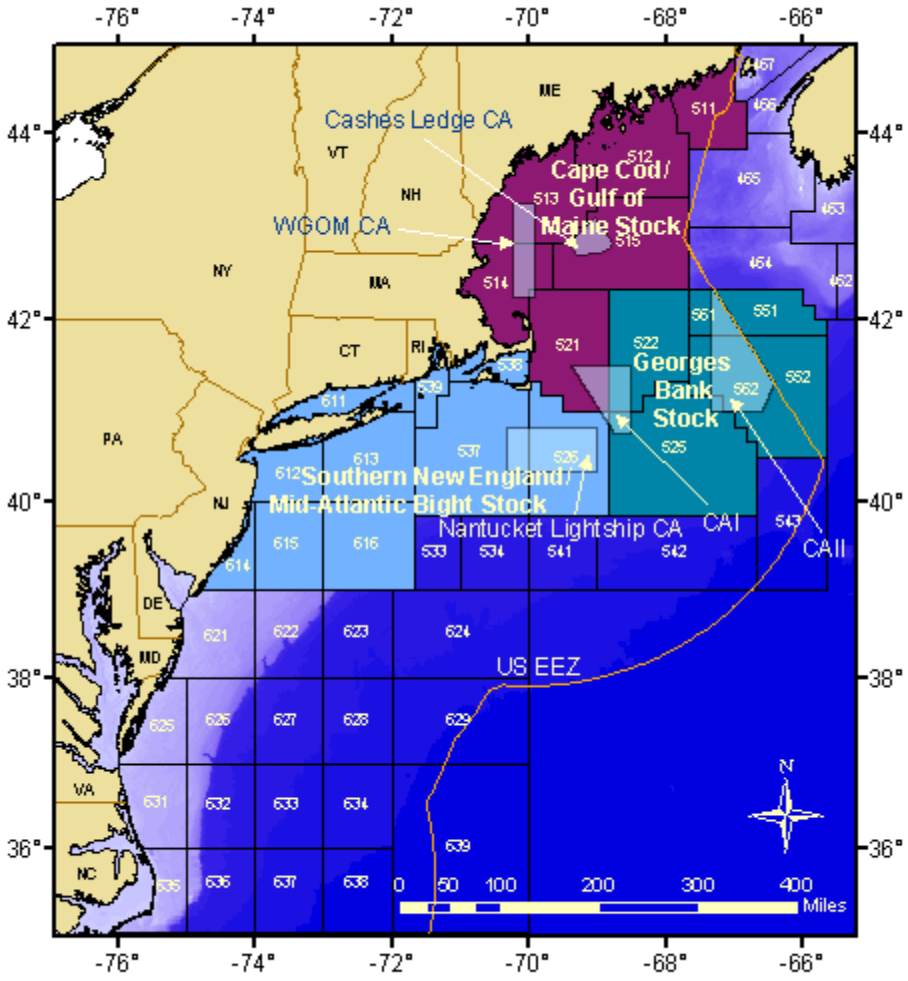

Figure 7.1. Statistical areas used to define the Cape Cod/Gulf of Maine, Georges Bank, and Southern New England/Mid-Atlantic Bight yellowtail stocks.

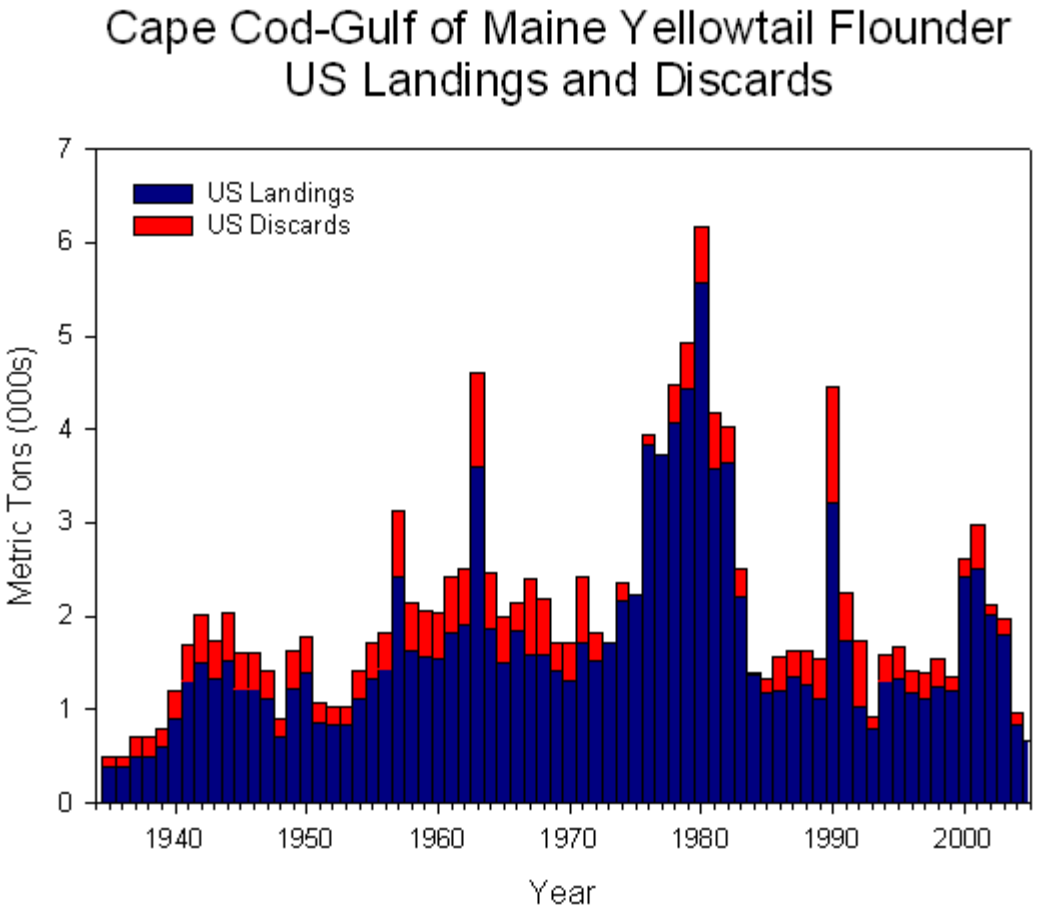

Figure 7.2. Catch of Cape Cod-Gulf of Maine yellowtail flounder, 1935-2005.

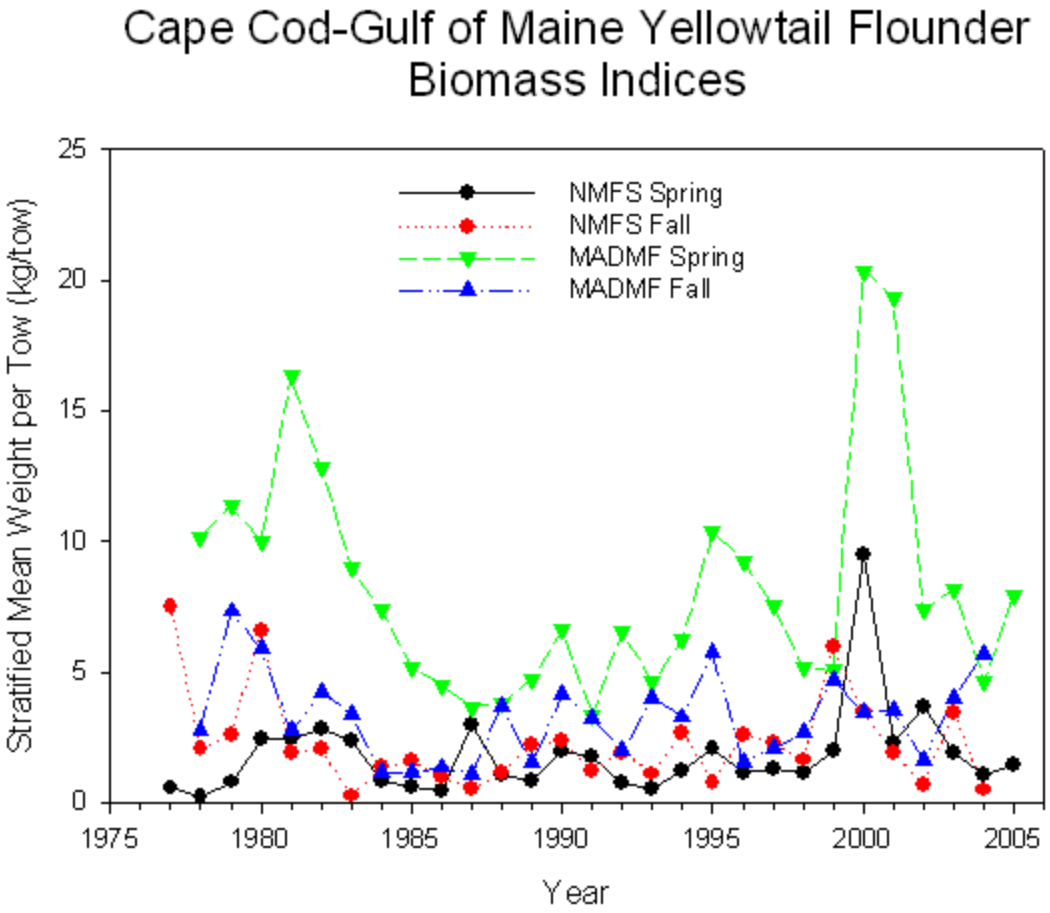

Figure 7.3. Biomass indices (stratified mean weight per tow) for Cape Cod-Gulf of Maine yellowtail flounder from NEFSC and Mass. DMF research vessel surveys.

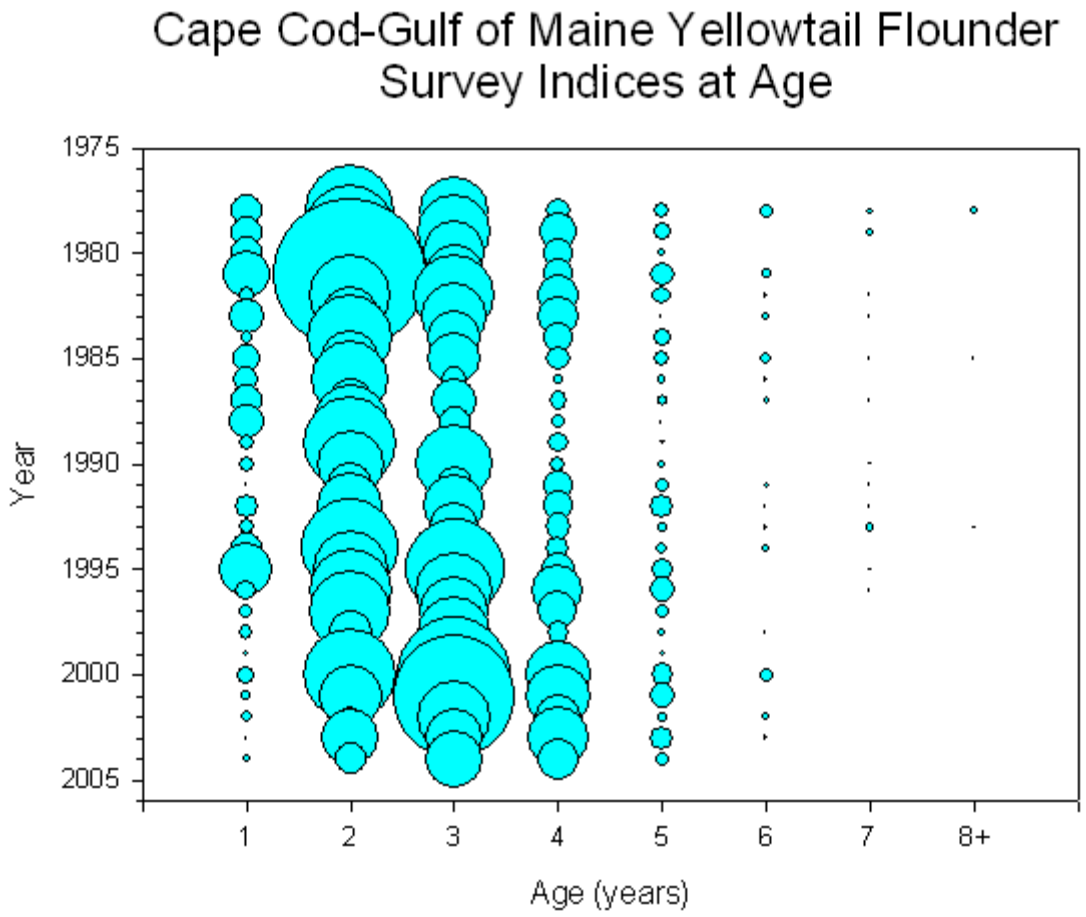

Figure 7.4. Age structure of the Cape Cod-Gulf of Maine yellowtail flounder Massachusetts DMF spring survey.

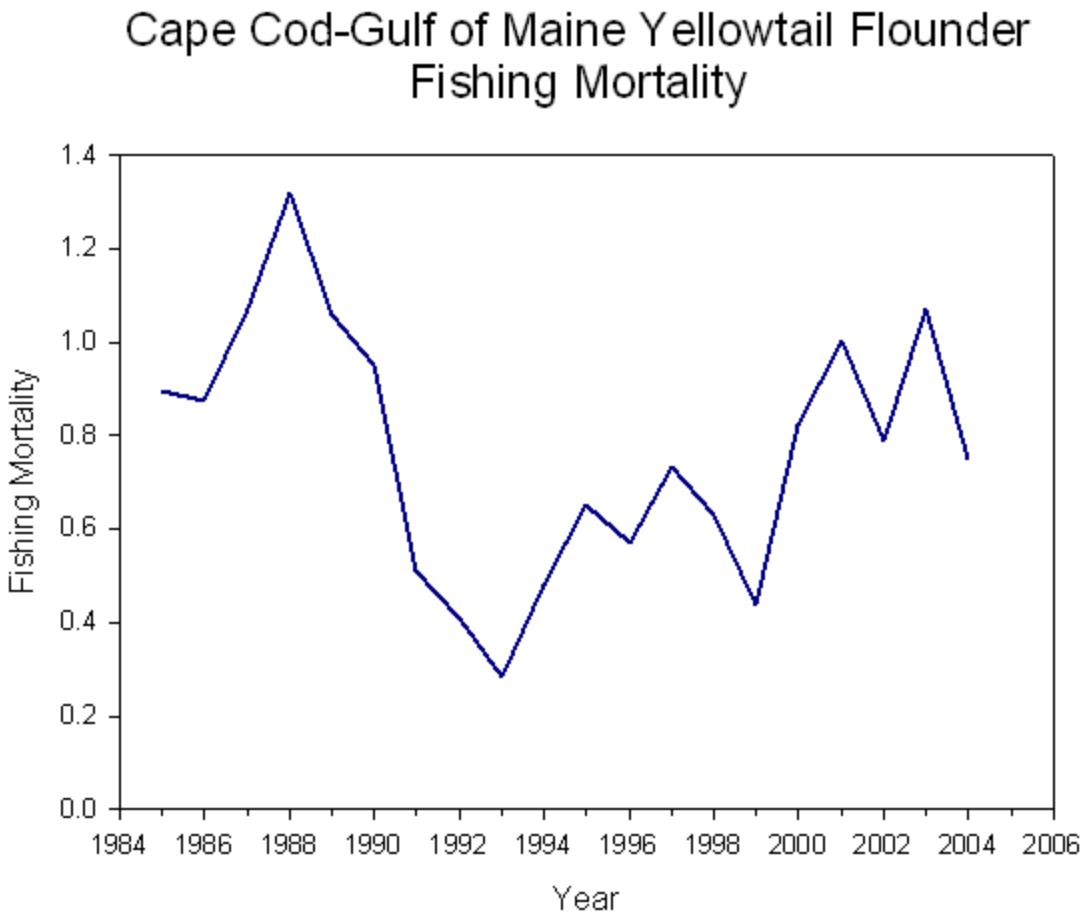

Figure 7.5. Average F (ages 3+ unweighted) for Cape Cod-Gulf of Maine yellowtail flounder.

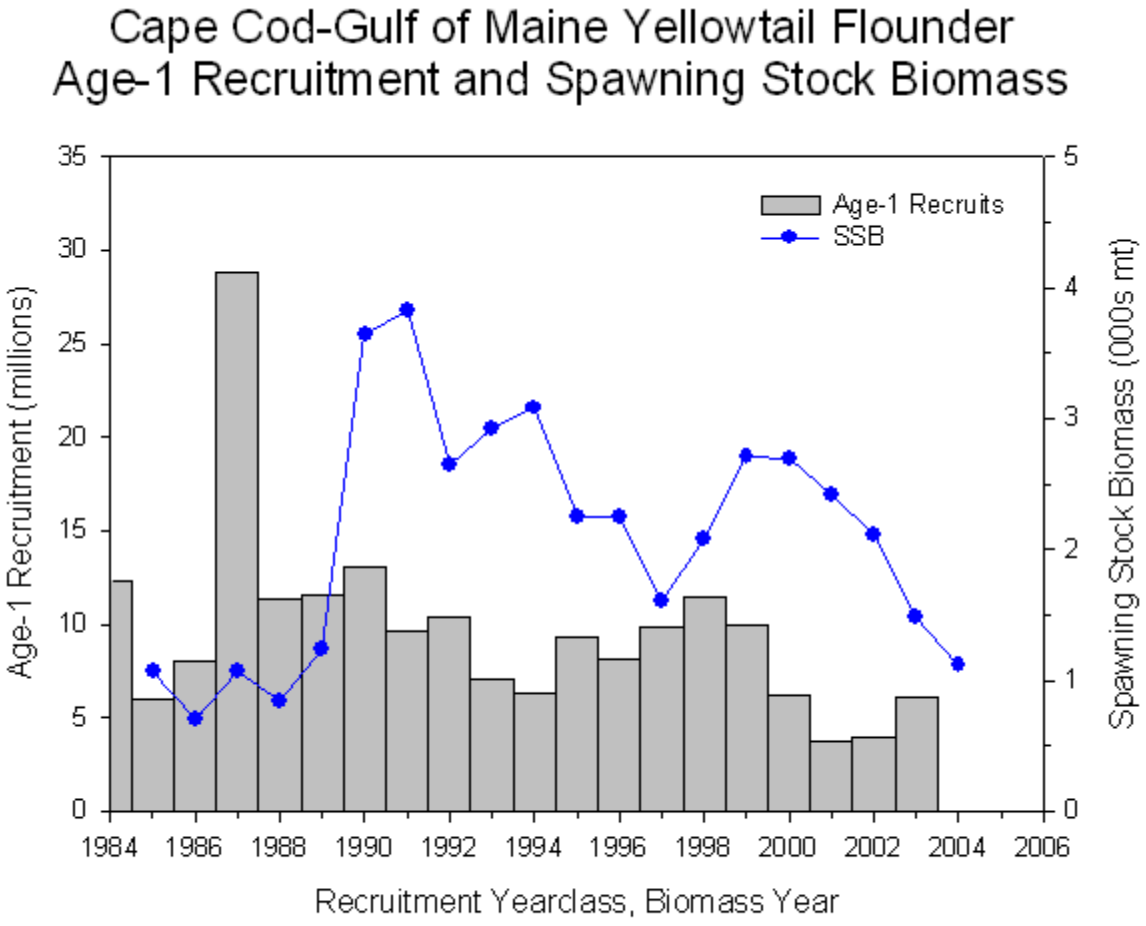

Figure 7.6. Trends in recruitment (age-1) and spawning stock biomass for Cape Cod-Gulf of Maine yellowtail flounder.

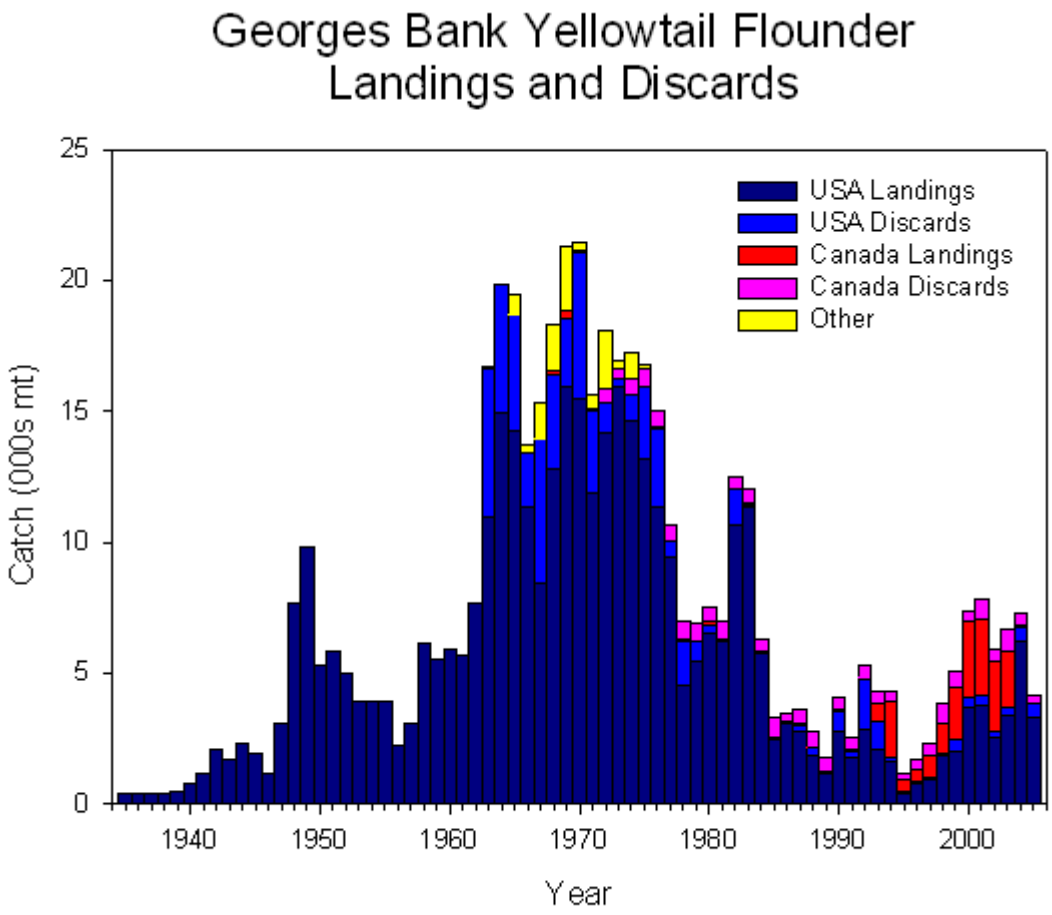

Figure 7.7. Catch of Georges Bank yellowtail flounder, 1935-2005.

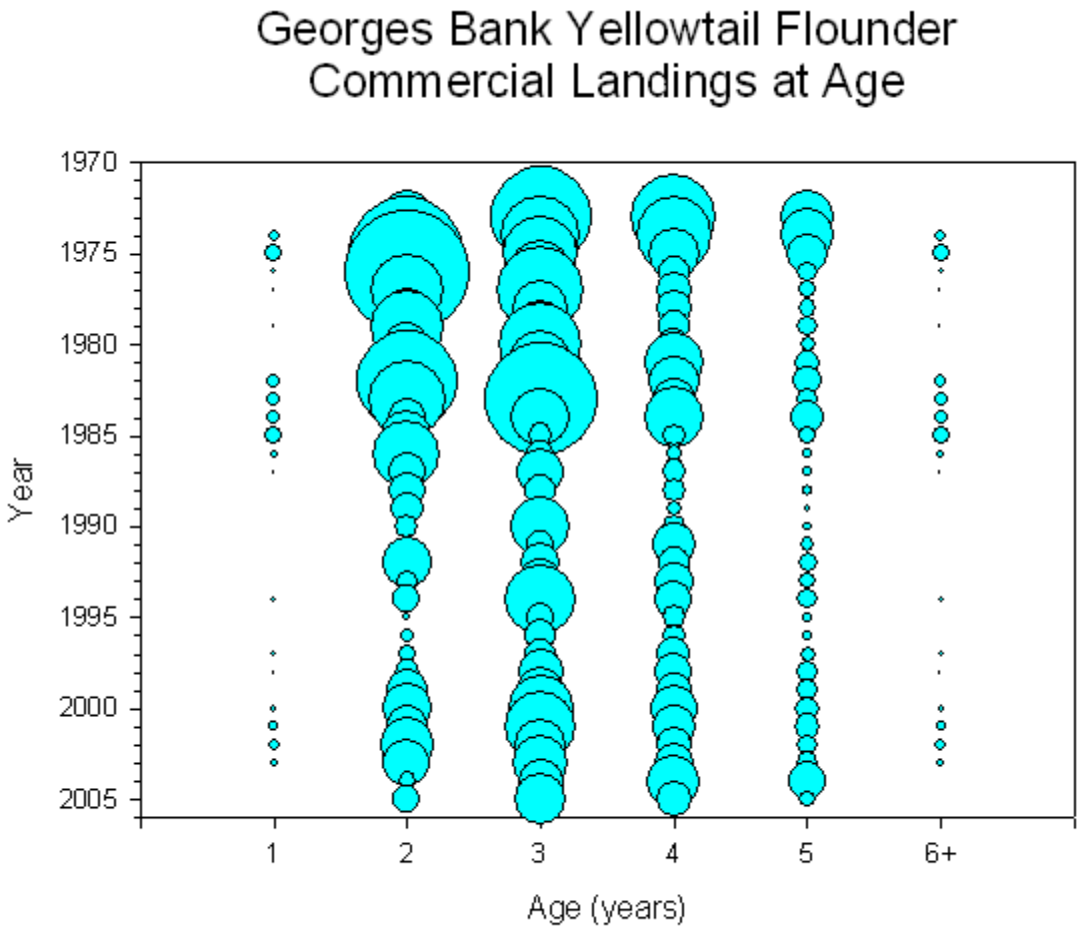

Figure 7.8. Age structure of the Georges Bank yellowtail flounder landings.

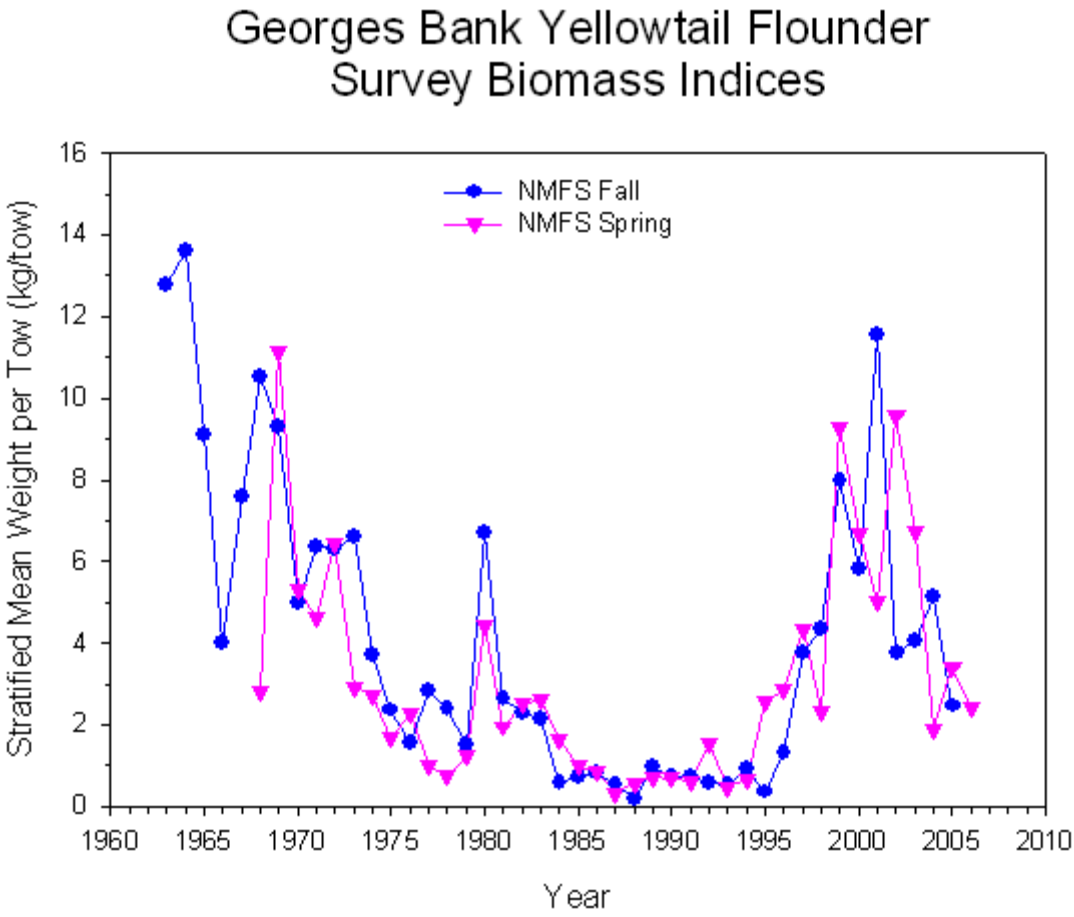

Figure 7.9. Biomass indices (stratified mean weight per tow) for Georges Bank yellowtail flounder from NEFSC research vessel surveys.

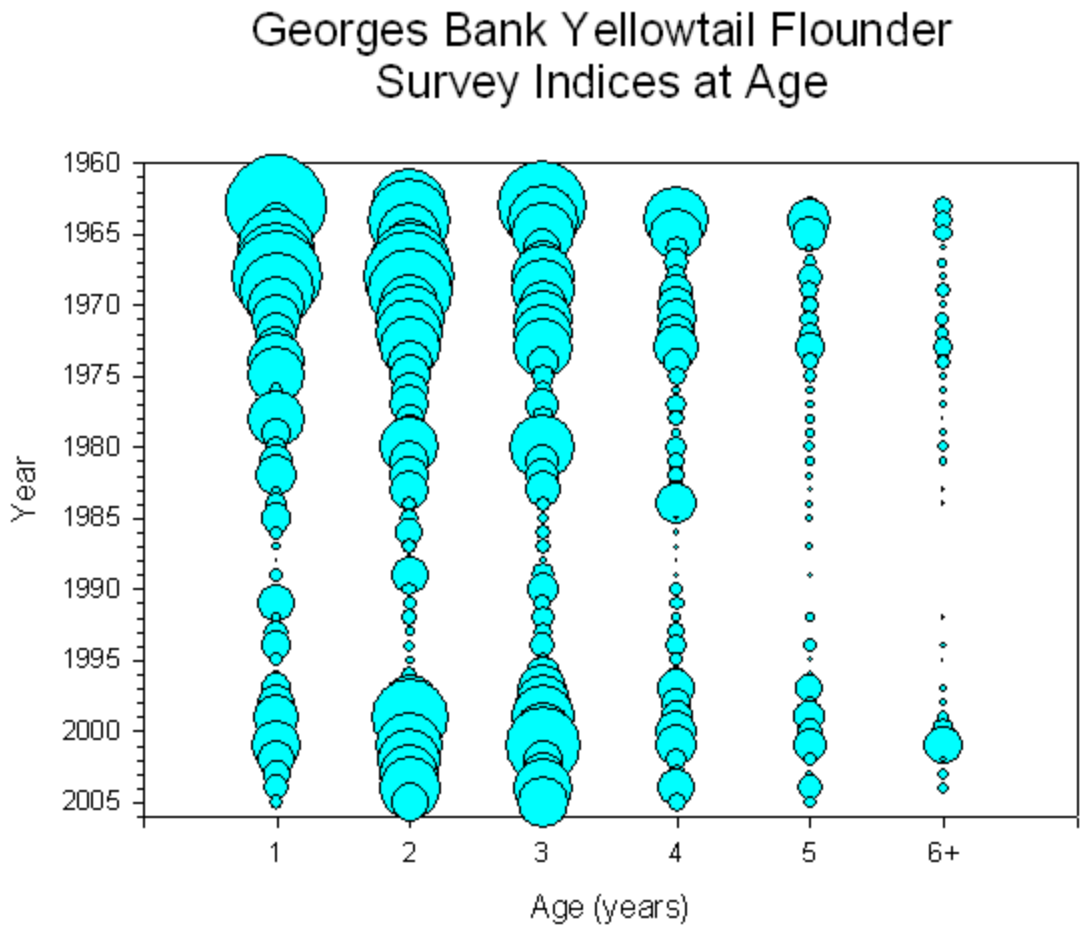

Figure 7.10. Age structure of the Georges Bank yellowtail flounder NEFSC fall survey.

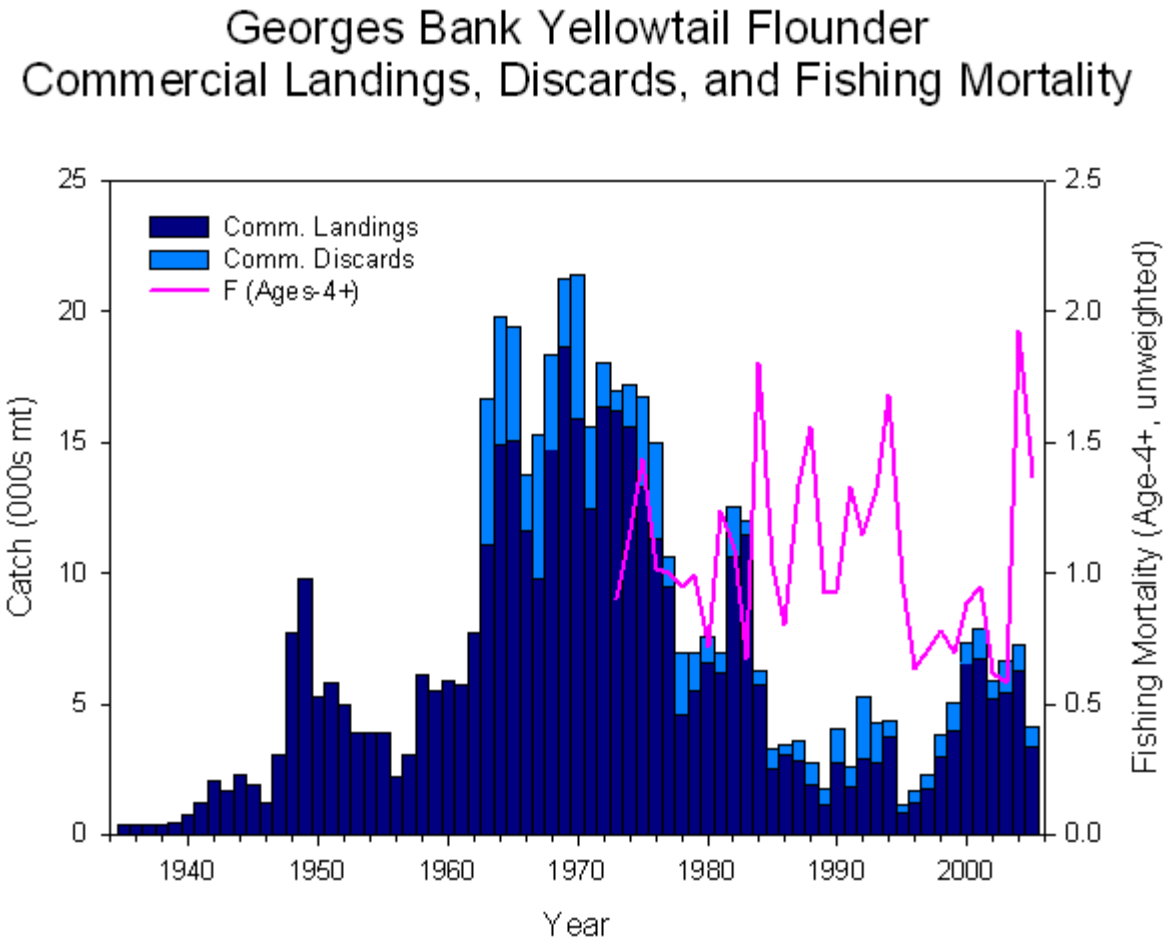

Figure 7.11. Trends in catch and fishing mortality for Georges Bank yellowtail flounder.

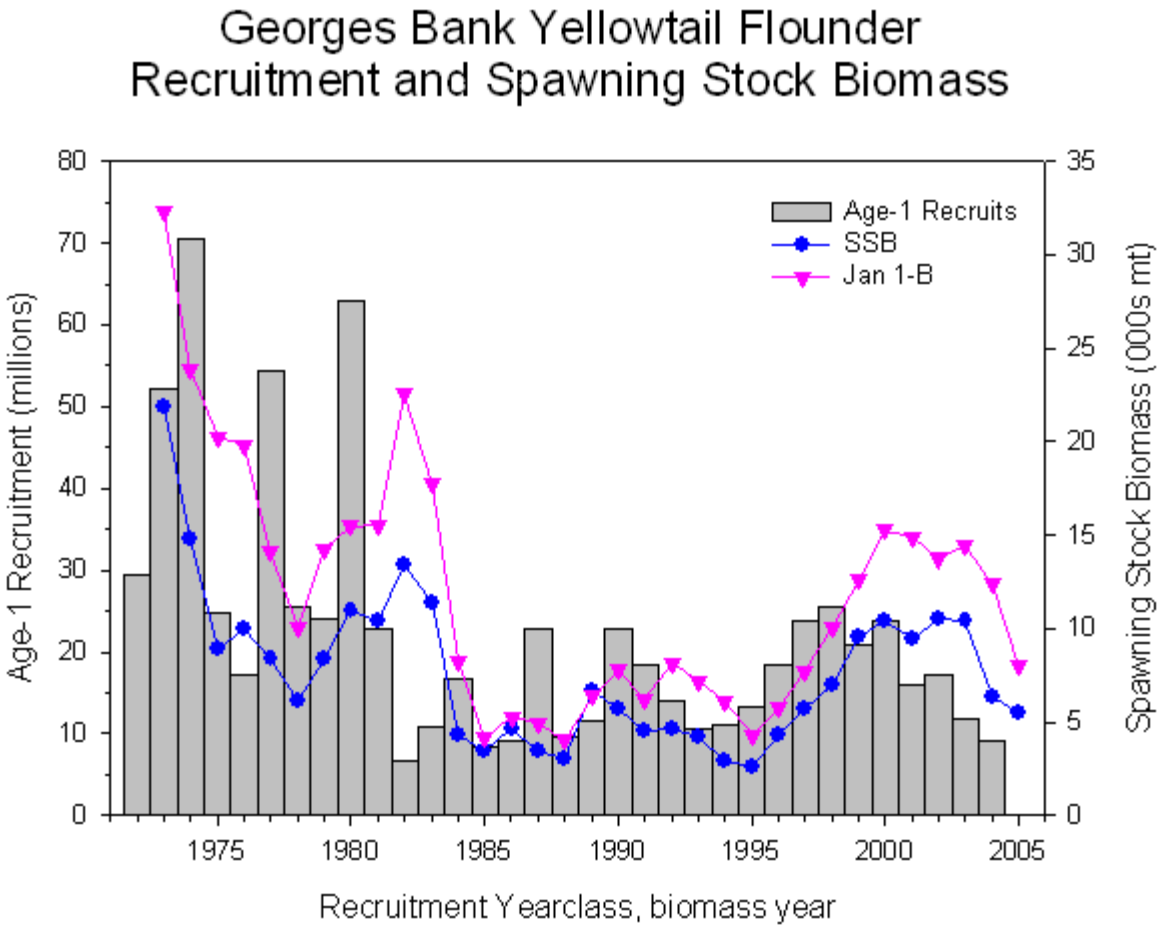

Figure 7.12. Trends in recruitment (age-1) and biomass for Georges Bank yellowtail flounder.

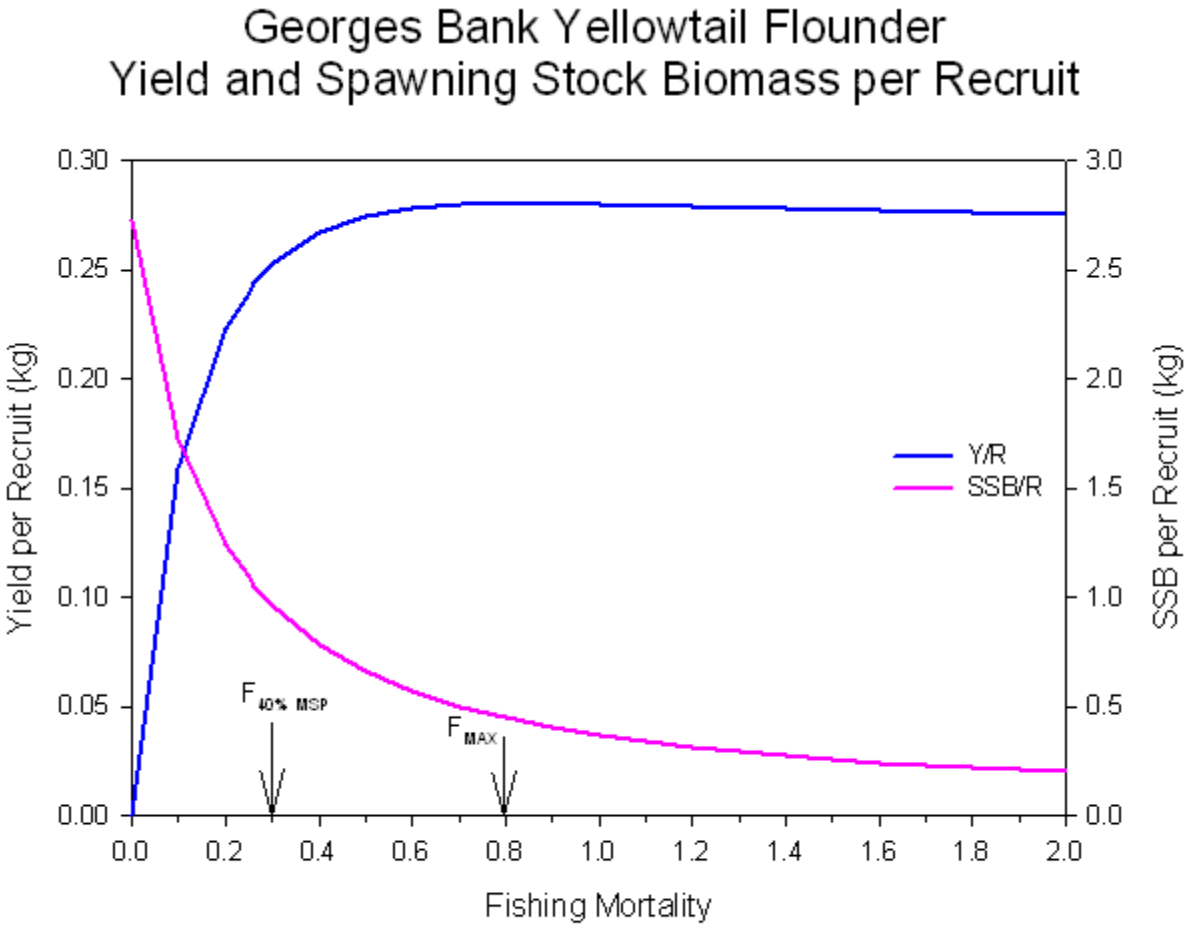

Figure 7.13. Yield and spawning stock biomass per recruit results for Georges Bank yellowtail flounder.

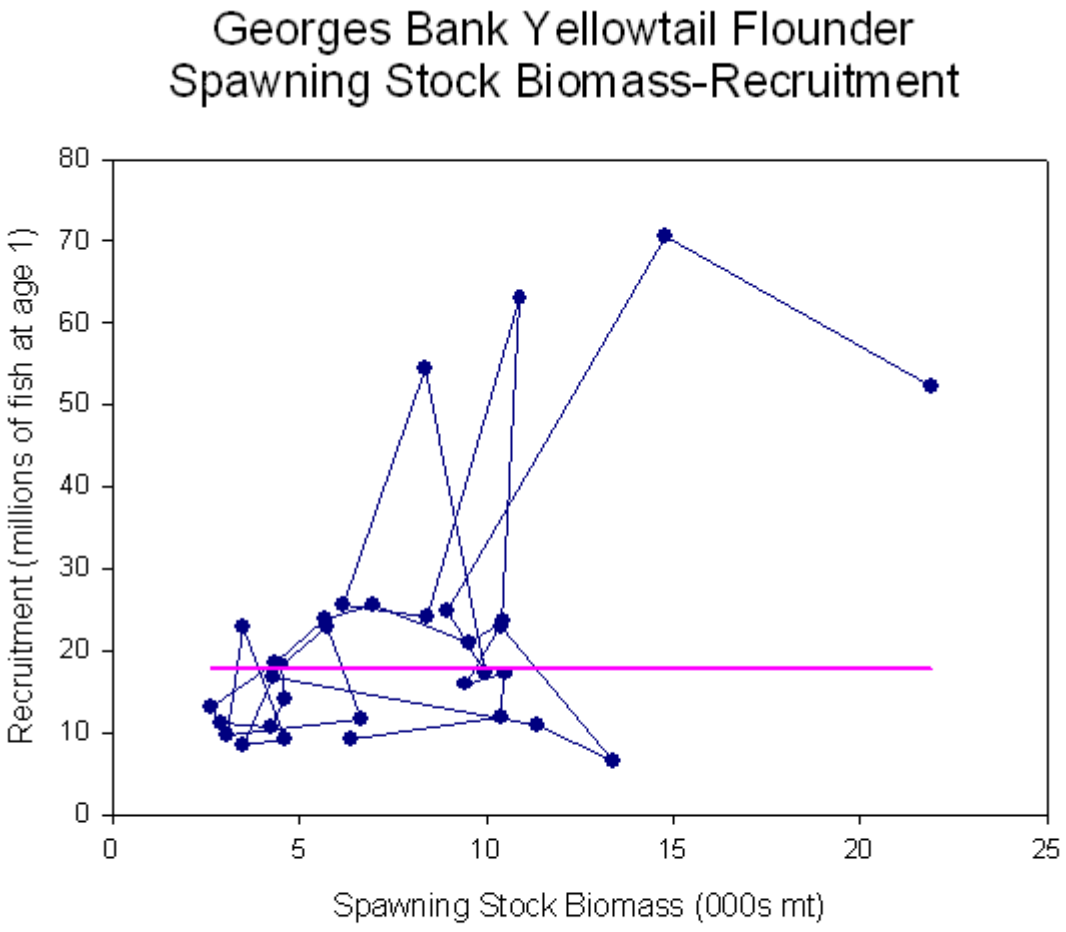

Figure 7.14. Spawning stock-recruitment scatter plot for Georges Bank yellowtail flounder. The horizontal line represents the median recruitment during 1973-2005 (18 million fish at age 1).

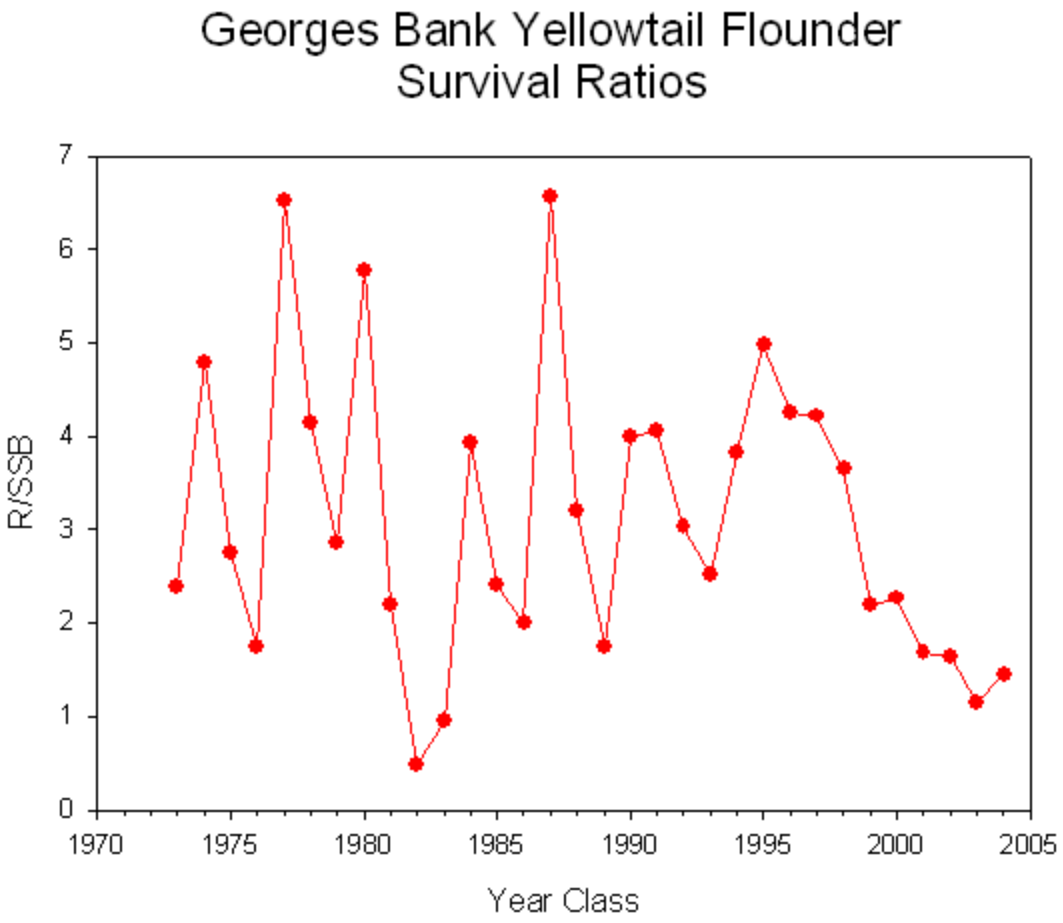

Figure 7.15. Trends in survival ratios (R/SSB) for Georges Bank yellowtail flounder.

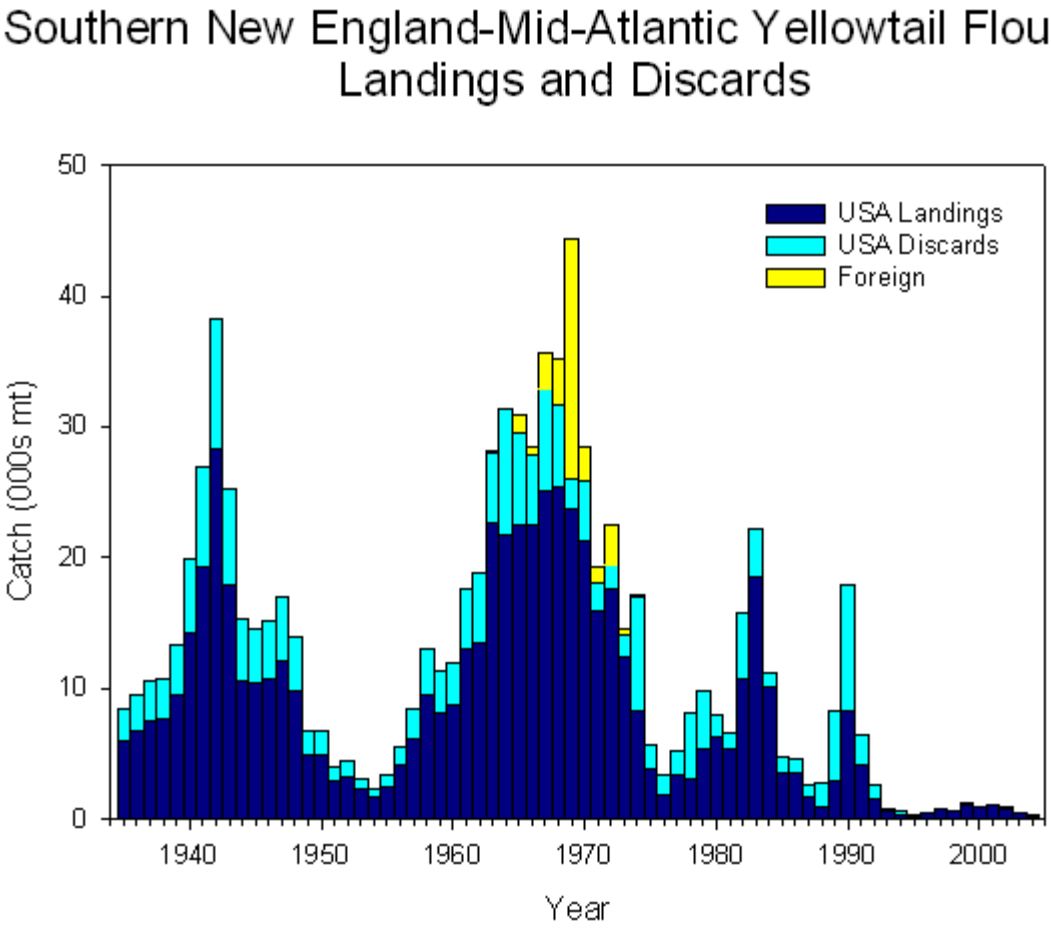

Figure 7.16. Catch of Southern New England-Mid-Atlantic yellowtail flounder, 1935-2005.

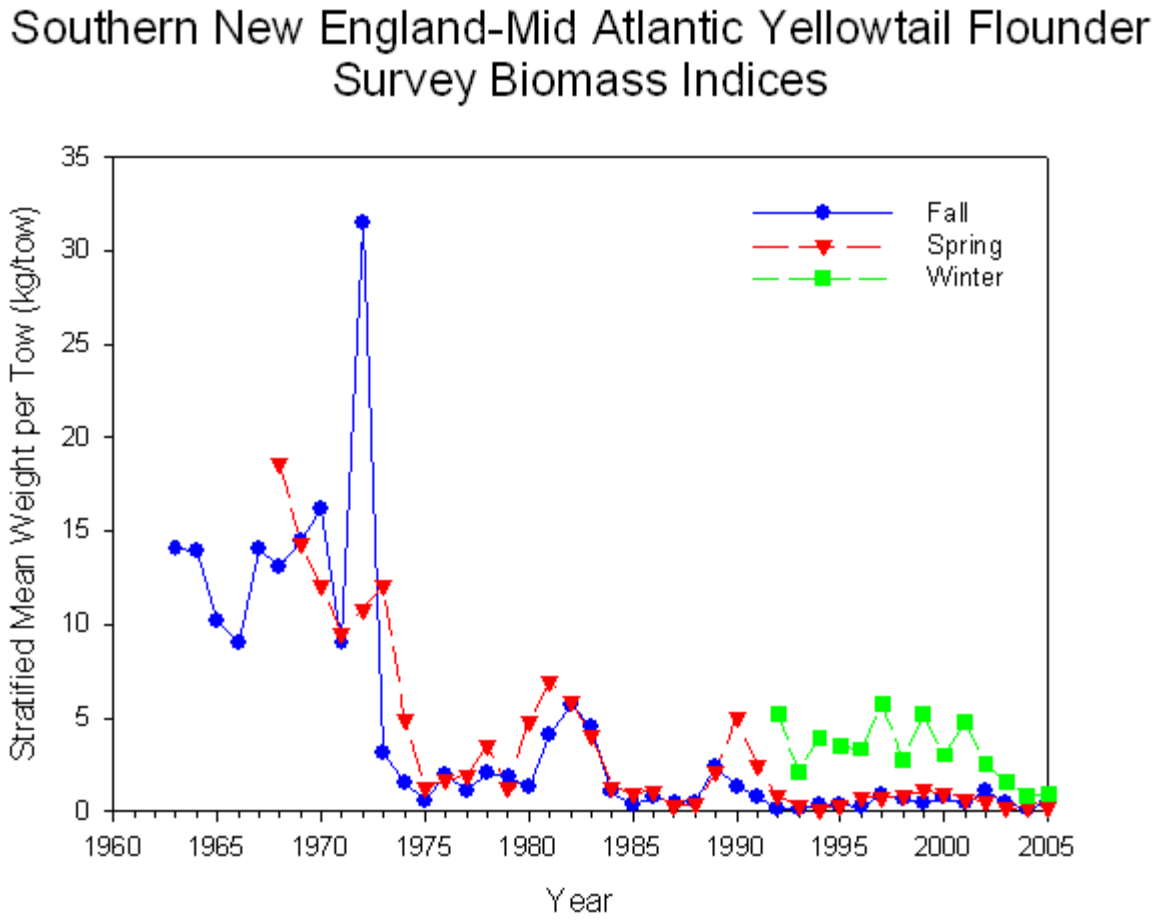

Figure 7.17. Biomass indices (stratified mean weight per tow) for Southern New England-Mid Atlantic yellowtail flounder from NEFSC research vessel surveys.

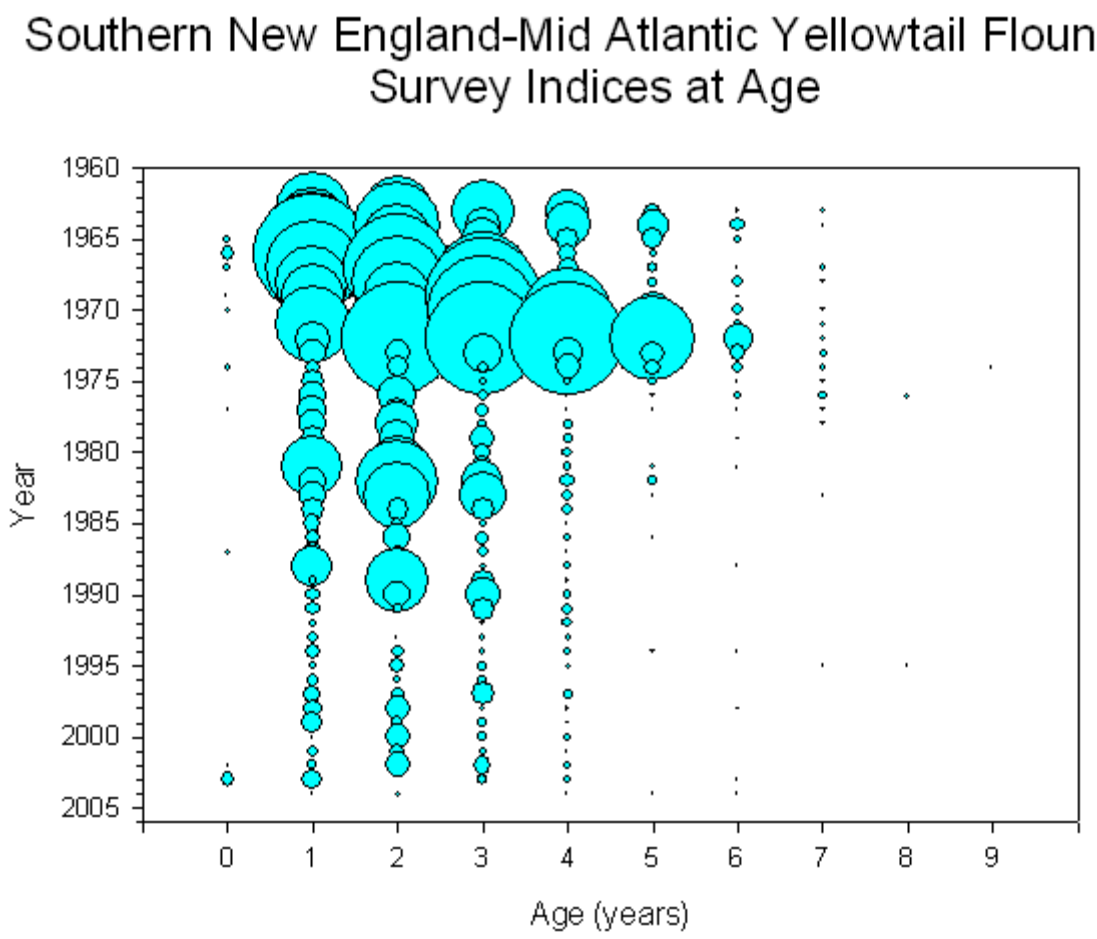

Figure 7.18. Age structure of the Southern New England-Mid Atlantic yellowtail flounder NEFSC fall survey.

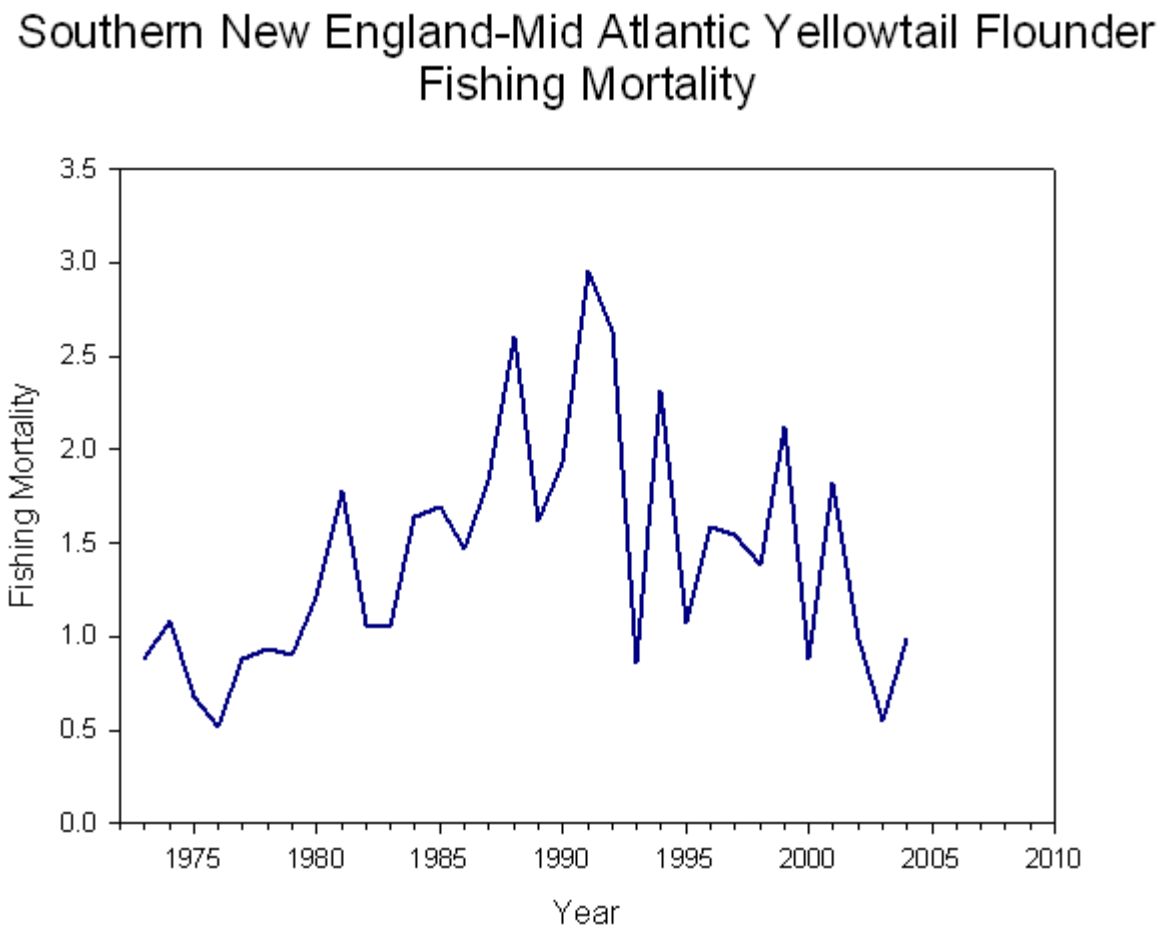

Figure 7.19. Average F (ages 4-6+ unweighted) for Southern New England-Mid Atlantic yellowtail flounder.

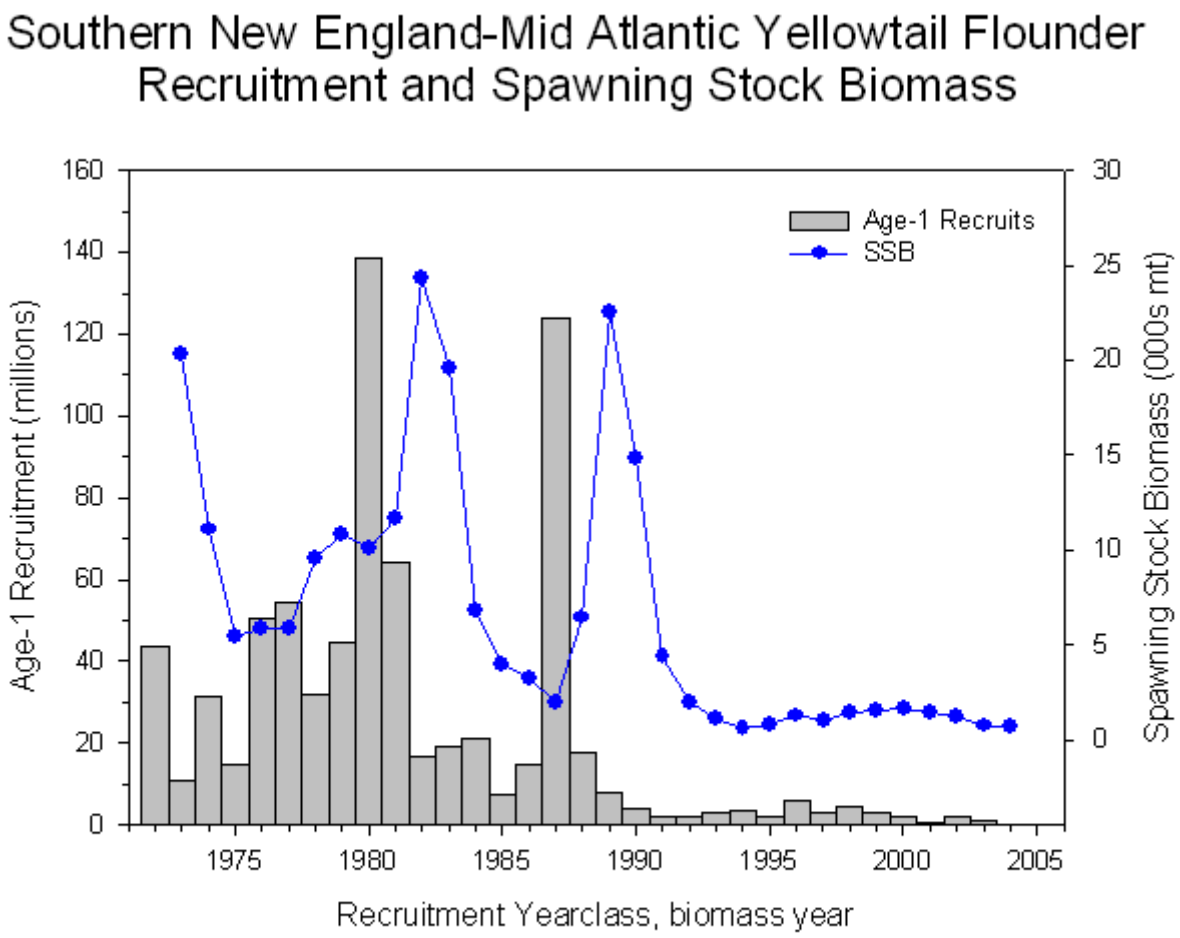

Figure 7.20. Trends in recruitment (age-1) and biomass for Southern New England-Mid Atlantic yellowtail flounder.